# Biology, Brain, and Behavior (Part 2)

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Psychology 216

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## Child and Adolescent Brain Development

- Frontal lobe connection and development
- Myelination
- Excitability

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## Prefrontal cortical development

- Prefrontal cortex responsible for reasoning, problem solving, decision making, planning, inhibiting behavior, control of emotions
- These capacities are not fully developed in childhood or adolescence
  - Fully developed in early 20s
- Lack of development gives rise to many of the behaviors typically associated with teenagers
  - Risky behaviors and decisions
  - Lack of good judgment, focus, control of emotions, planning, foresight, etc.

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## Myelination

- Myelin-
  - fatty material that develops around axons
- Myelination is the formation of myelin around axons
  - Begins in brain before birth and continues in adulthood
  - Substantial myelination development in adolescence
- Myelination allows the brain to process and communicate information more quickly and efficiently

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## Excitability

- Some believe the brain is more "excitable"
- More easy stimulated for growth
- Learning may be facilitated
  - Good and bad
    - For example,
      - may be able to adapt and learn new skills easier
      - may be more susceptible to addictions

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## Core Knowledge Hypothesis

- Humans have a set of rich innate cognitive abilities
  - Language
  - Quantity
  - Spatial representation
  - Objects
  - Social thought/psychological reasoning
- Each is specialized and distinct from one another
- These specialized abilities, combined with our general ability to learn and remember, form the basis of further learning and cognitive development
- Spelke, Carey, Baillargeon

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## Conceptual Test Case: Face Processing Overview

- What portion of mature face processing abilities are innate?
- Which are present at birth?
- How does experience change face processing?
- What contribution do controlled rearing studies make?
- Is there a sensitive period for face processing?

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## Mature face processing system

- A specialized system for processing and recognizing faces
  - Differentiating faces from non-faces (objects, scenes, etc.)
  - Distinguishing between and remembering individual faces
  - Distinguishing complex social cues for interaction (emotion, threat, like me or not…)

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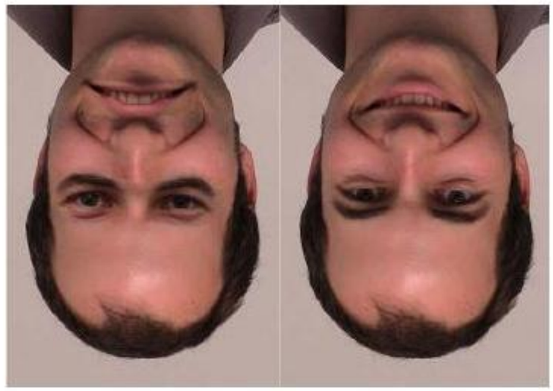
# Evidence for a specialized system: inversion



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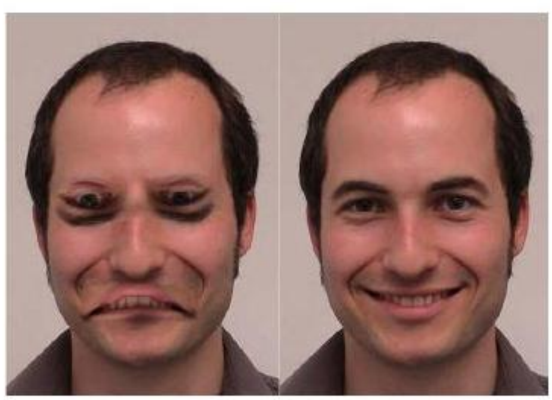
# Evidence for a specialized system: configuration



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# Evidence for a specialized system: species-specificity

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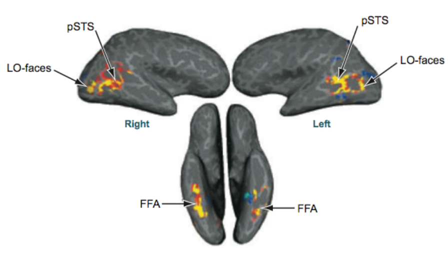
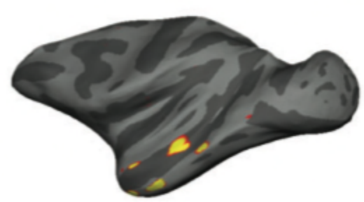
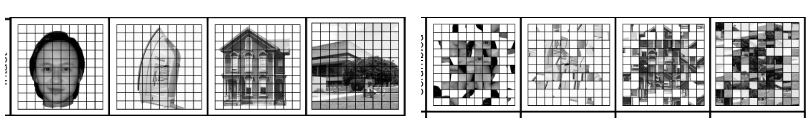
# Evidence for a specialized system: face selective cortical regions

Humans




Monkeys





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## Evidence for a specialized system: prosopagnosia

- Significantly diminished ability to recognize and remember faces
- Often results from brain damage to face selective regions of the temporal lobe
  - Can not recognize own parent or siblings face
  - Have to rely on other social cues or “tricks” to navigate daily encounters.

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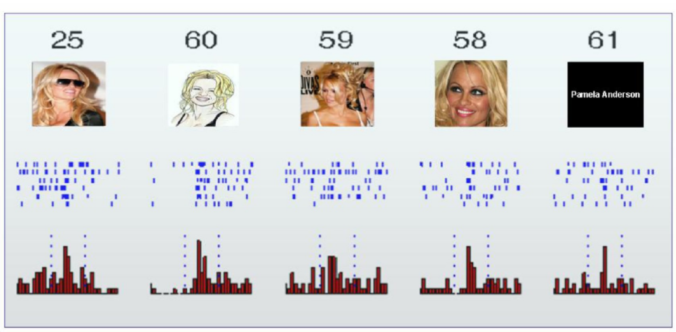
## The Pamela Anderson Neuron: Single cells respond most to certain faces:

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# Origins

- Where does sensitivity, selectivity, and specialization come from?
  - Develops through experience with faces?
  - Develops later in life through biological maturation?
  - Present from birth?

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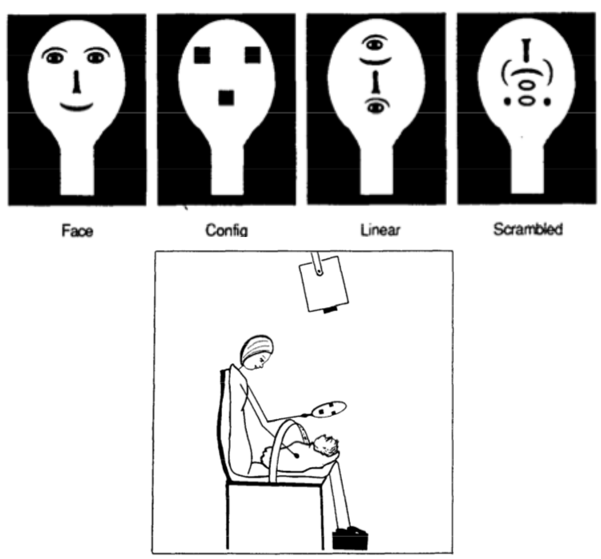
# Neonatal facial preferences (Johnson et al., 1991)

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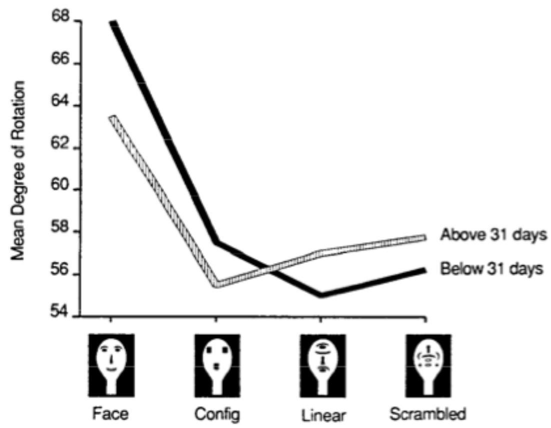
## Infants prefer to follow/look at faces over non-faces

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## How specific is processing at birth?

- Cassia et al., 2004: preferential looking study

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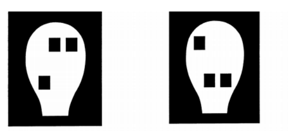
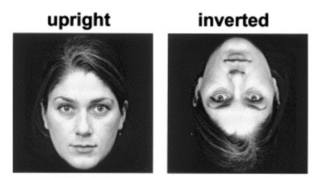
# Neonatal Face Preferences

- From birth attracted to and track things that resemble a face
- Top heaviness is important to determining what is a face



Upright stimulus    Upside-down stimulus

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# Infant Face Perception Development DVD Clip

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## Face processing changes over the first year of life

- Perceptual narrowing for familiar faces
- Abilities tuned to own race faces over the first year
  - Kelly et al., 2007
    - 3 months Caucasian infants can distinguish between multiple races
    - By 9 months, only Caucasian

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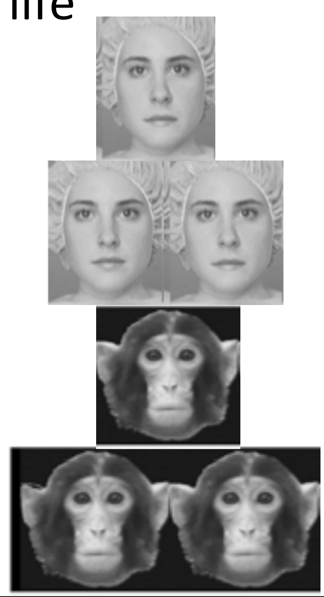
## Face processing changes over the first year of life

- Perceptual narrowing for familiar faces
- Abilities tuned to own species over the first year
- Scott, Pascalis, and others
  - 3 month old infants can distinguish between faces of own species and between faces of other species (monkeys)
  - By 9 months, only human faces



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Face discrimination example
Same or different?

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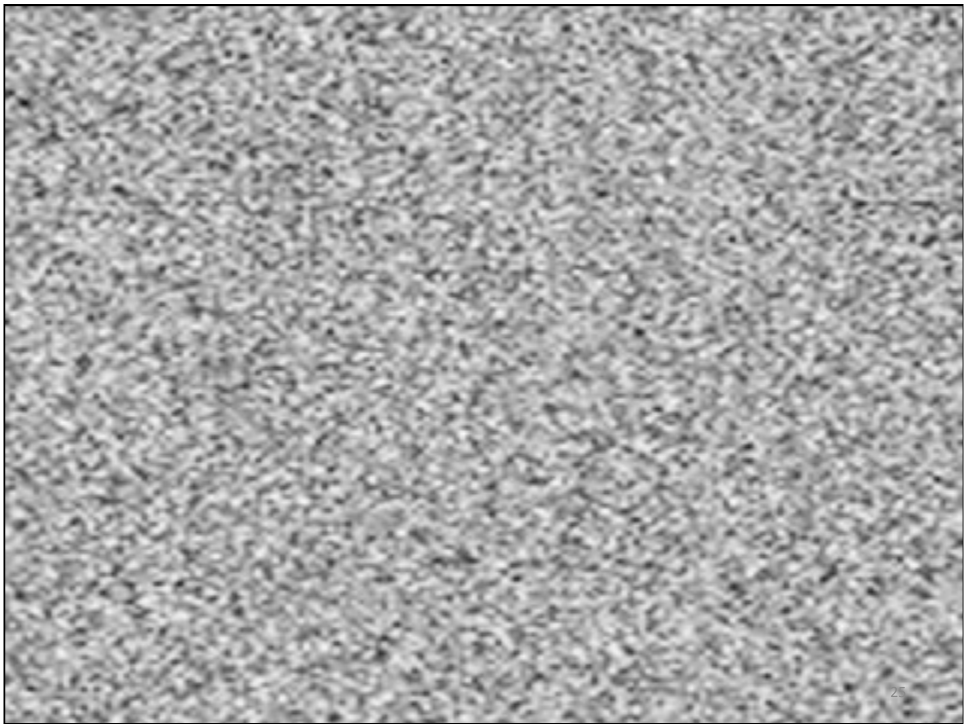

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Same or different?

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Ready?

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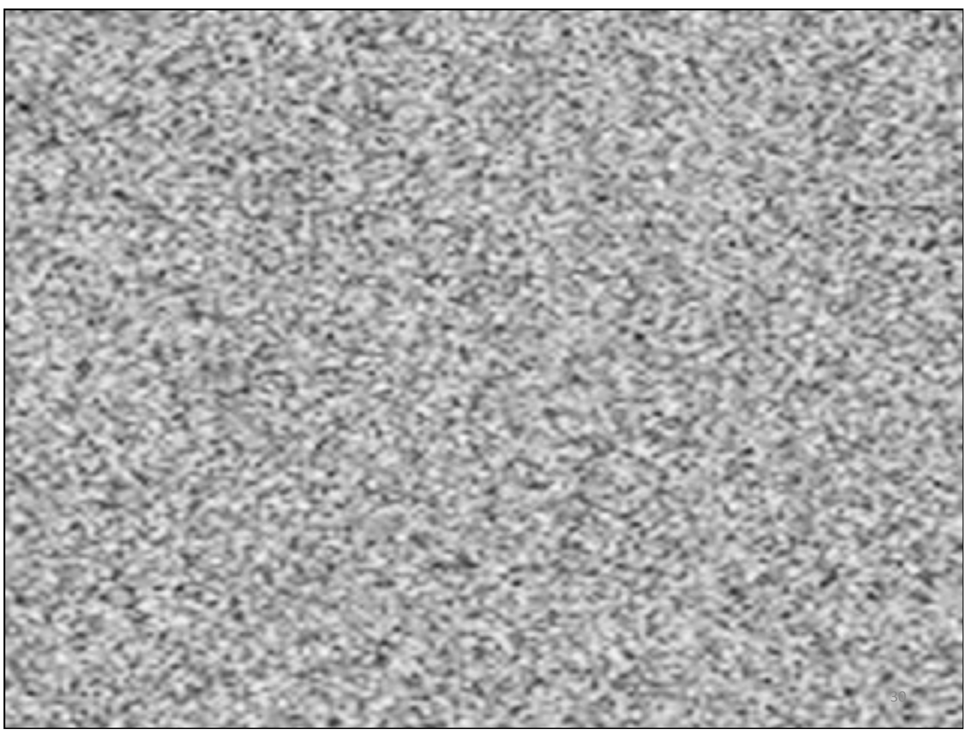

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Same or different?

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# Ready?

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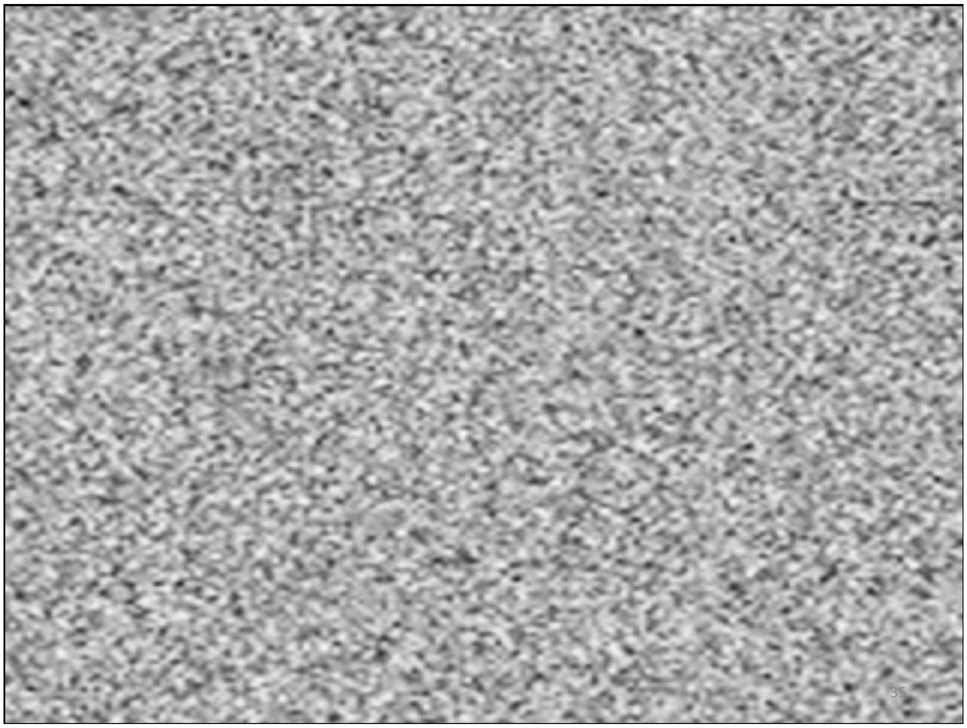

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Same or different?

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## Extended experience changes pruning for faces (Pascalis et al)

- Researchers asked if further exposure to monkey faces would prolong ability to discriminate between other-species faces
  - Pretest, training, and post-test
  - Training group/control group-6 months
    - Training group looked through a book of monkey faces everyday for
  - At 9 months, the training group retained the ability to discriminate between monkey faces where the control group did not
- Found that extended experience prolongs narrowing

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# What happens if you aren't exposed to faces?

- Controlled-rearing study of monkeys (Sugita reading)
  - Deprived of face input for 6 months, 1 year, or 2 years
  - Then exposed to either monkey or human faces
  - Compared to a control group with typical monkey face experience
- Tested on face processing abilities before, 1 month after and 1 year after deprivation


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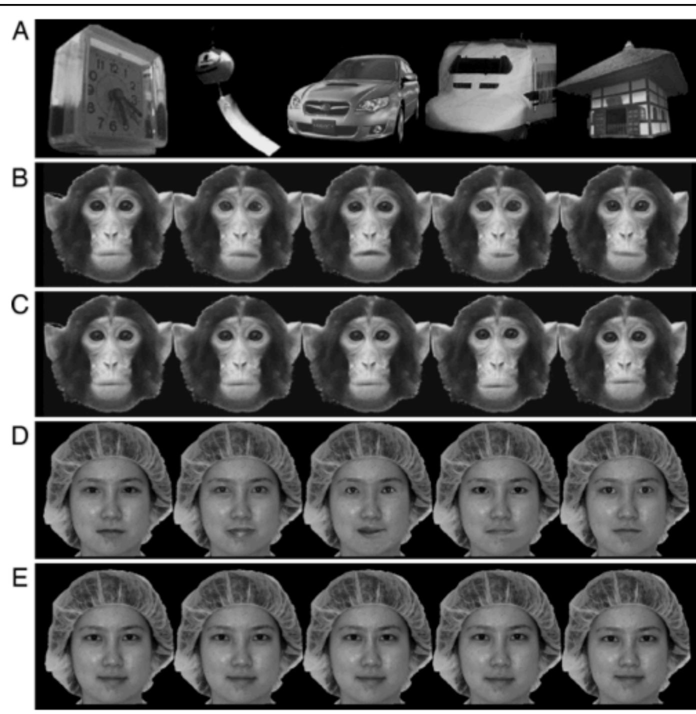


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## Pretest During Deprivation

- Preferential Looking
  - All preferred faces over non-faces
  - Deprivation groups had no species preference
  - Control group preferred monkey faces over human faces
- Visual paired comparison (familiarize and then test with 1 novel and 1 familiar)
  - Face-deprived monkeys could distinguish a novel and familiar face of either species
  - Control monkeys could only distinguish between novel and familiar monkey faces

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## After deprivation and subsequent 1 month first exposure

Visual preference

- Animals preferred to look at face-type to which they were first exposed (human or monkey)
- Did not prefer non-exposed type of face over objects after exposure
- Preferences did not change after a year of recovery
  - Evidence for strong role of earliest experiences
  - Imprinting?

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## After Deprivation (1 month and 1 year)

Visual Paired Comparison

– Animals distinguished only between species of first exposure
– No difference in groups by length of deprivation
– No change after a year of recovery



## What conclusions can we draw from the Sugita controlled rearing study?

- Bias for faces over non-faces is innate
- Ability to tell the difference between different faces is innate and broadly tuned to (all) plausible faces
- Specificity for own-species is based on early experience
- Plasticity in the system allows for prolonged deprivation (at least up to 2 years in monkeys)
- First exposure/early experience, when it occurs, has long lasting effects on neural tuning

## Implications of face processing for clinical child development and education

- Cases of impaired face processing
  - Autism
  - Prosopagnosia/Developmental prosopagnosia
  - Congenital cataracts
  - Neglected Orphans (e.g. Romania)

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## Autism

- Autism-disorder of neural development
  - characterized by
    - Impaired social interaction
    - Impaired communication
    - Restricted or repetitive behaviors
  - Autistic children often have difficulty making eye contact
  - Many autistic children appear to be uninterested in typical social interaction or social play
  - Prefer to look at geometric shapes or mechanical items over faces/social stimuli
- Currently 1 in 88 children receive a diagnosis on the Autism Spectrum (CDC, 2012)

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## Behavioral clip of children with Autism (DVD)

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## Is face processing impaired in Autism?

- Autistic individuals appear to go about it in the same way when encouraged to do so
- Spontaneous face processing may be different
  - Tend to spontaneously look at different regions of the face/head
  - Tend to spontaneously engage different brain regions
  - Do not (or do not the same extent) spontaneously engage fusiform face regions (FFA) of the temporal lobe typically associated with face processing
  - Autistic individuals are quantitatively worse at it than typical peers
- May spontaneously receive a different amount and/or type of input
- Many open questions

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# Limitations to our understanding

- Non-representative samples
  - Almost all studies use high-functioning Autistic individuals
    - Must include those that are willing to cooperate, can understand all the directions
      - Usually includes only the least severely impaired and most intelligent
- Very limited knowledge of
  - the origin of Autism
  - the role of face deprivation on further development
  - early brain and behavioral development
  - the best course of treatment

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# Using lack of interest in face processing to diagnose?

- Eye-tracking study by Pierce et al., 2010
- Method
  - 14 month olds allowed to watch a movie with geometric patterns or children dancing
  - Measured proportion of looking to each video
- Results
  - 100% of children watching the shape video more than 70% were classified as having an Autism spectrum disorder
  - 50 out of 51 typically developing children preferred the video of children dancing

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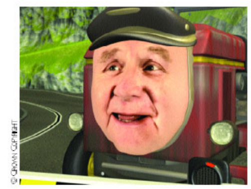
## Use heightened interest in mechanical/geometric objects to encourage face processing

- Simon Baron-Cohen and colleagues
- The Transporters DVD
- Take advantage of interest in moving/ working parts and objects
- Encourage interest in faces by placing faces on trains



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## Prosopagnosia/face-blindness

- Neuropsychological disorder characterized by impaired ability to recognize faces
- Can be caused by brain damage
  - Damage to fusiform brain regions
- Can be genetic (some appear to be born with it)
  - Possibly about 2%-2.5% (maybe ~5 people in this class?)
- No systematic form of therapy
  - Often alleviated by alternative strategies

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# Cataracts

- Congenital cataracts impair vision from birth
- 1-6 cases per 10,000 births
- Most common treatable cause of visual impairment
  - Earlier removal leads to better developmental outcomes
  - Face processing is often impaired dependent on the duration of deprivation

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# Cataracts

- Project Prakash
- Partnership of scientists and doctors from U.S. (Pawan Sinha-MIT) and India
- Goal is to help alleviate curable blindness in India
  - Help disadvantaged receive surgery
- Learn about the visual processing after deprivation
  - Study consequences of surgery for the development of vision

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# Romanian Orphans

- Romania has vast number of unwanted children institutionalized in orphanages
  - About 20,000 children in orphanages as of 2010
- Resulted in a severe lack of physical care/attention for orphans
  - Ratio of 1 caregiver to up to 20 infants
  - Spend a majority of time laying in crib without human contact
  - Deprived of typical levels of facial content and expression
  - Impaired ability to recognize emotional facial expression and those expressions to appropriate social contexts.

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# Natural study of social deprivation (Nelson et al., 2007)

- Randomly assigned children to foster care or remain in institutions/compared to children growing up in typical family environment
- Measured cognitive, physical, and behavioral development
- Three main findings
  - Children reared in institutions showed diminished intellectual performance (often mental retardation) compared to controls
  - Foster care children made significant gains in development
  - Sensitive period of intervention (applies to face processing)
    - Generally those that were adopted before 2 years had much better outcomes than those adopted after 2 years
    - Younger placed in foster care, better the outcome

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# Conclusions

- Humans start out life with biases that turn attention towards faces as well as the ability to distinguish between all faces
- Over the first year of life, our brain tunes itself to the type of face we are familiar with
- Controlled rearing studies show us that nature controls the initial biases and experience further specializes the brain
- Information learned from studies of face processing is applicable to clinical and education settings

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